Tests for Cement Soundness.

It is probably not often realised that the acceptance of the boiling-water or steam test as an indication of the soundness of cement implies faith in a belief that such accelerated tests reveal the behaviour of the cement at long distant periods. There has seldom been any direct evidence to confirm this faith, but in some results recently published by Professor A. H. White (of the University of Michigan, U.S.A.) there is welcome information covering a period of 26 years. It has been common knowledge that set cement expands slightly when kept moist and contracts on drying; with neat cement such expansion may amount to 1 part in 700 on immersion in water, while the contraction may reach 1 part in 200 on drying, compared with the original volume of the test piece immediately after setting.

These volume changes are of course proportionately reduced when the cement is mixed with aggregate, and therefore have little practical significance except in long stretches of concrete, as in road work where special provision is made by the introduction of joints filled with an elastic material. Apart from these changes in volume, which can be considered as only natural in a material which is to some extent of a colloidal nature, there is the possibility that expansion may occur due to defects in the chemical composition of the cement or in its method of manufacture. The fear of such expansion is a legacy from the days when the manufacture of cement was crudely conducted and when in some cements there was undoubtedly a proportion of uncombined or partially-combined lime contained in coarsely-ground particles which expanded when penetrated by water. Hence the necessity for the introduction of an accelerated test, which has undoubtedly been the means of eliminating expansive cements.

Professor White's observations show clearly that a cement which is sound to the steaming test does not expand or contract during periods up to 26 years beyond the natural extent already referred to as arising from the colloidal nature of the cement. There is, however, one exception to this, namely, in

connection with the magnesia content, and it is shown that cement of normal composition but with an addition of 3 per cent. of finely-ground hard-burnt magnesium oxide behaved normally for as long as three years in water but thereafter showed marked expansion, growing in 26 years to as much as 1 per cent. With 4 per cent. added magnesia the expansion exceeded 2 per cent. It should be noted, however, that this was added magnesia and not magnesia combined with argillaceous constituents. The experiments show that a cement containing 53 per cent. of magnesia, or approximately 2½ molecules of magnesia to 1 of argillaceous constituents does not show any abnormal expansion after 26 years in water, evidently because the magnesia was firmly combined with silica and alumina. The strength of this cement was of course very low, and there is apparently no future for magnesian cement as a commercial material.

The investigations concerning the effect of large proportions of magnesia in a cement of otherwise ordinary composition are very valuable because it is usually impossible to detect the adverse effect due to magnesia by the ordinary soundness tests. In a cement containing 7 per cent. of magnesia, which was sound to an accelerated test, the expansion in water during the first year was not abnormal, but at the end of the fourth year exceeded 0.3 per cent., and thus indicated some instability due to magnesia. Weathering of the clinker for six months in the open air did not eliminate the expansion entirely, although it reduced it so that the movement after 16 years in water was no more than 0.26 per cent.

Some distinction requires to be made, however, as to the form in which the magnesia is present. As previously stated, free magnesia actually added to cement is notably expansive in the course of time, and the cement just referred to, where the excess magnesia was introduced in the raw materials, had such magnesia in the form of carbonate. In many cases, however, the magnesia present in cement is derived from silicate of magnesia forming part of the argillaceous constituent and not as carbonate introduced with the calcareous constituent of the cement raw mix. In the case of a cement containing 4.45 per cent. magnesia where the molecular ratio of lime to silica and alumina exceeded 2.5 it is evident that the alkaline earth constituents were in excess because such cement showed an abnormal expansion exceeding 0.4 per cent. in the course of years. These results suggest that a high magnesia content is only permissible when the lime content is comparatively low, and the combination of high lime and high magnesia is one to be avoided.

The value of increasing the iron oxide content in cement is becoming more appreciated, and Professor White's investigations show that its value is not restricted to the ordinary soundness and early date tests but is continuous throughout the history of the cement, because cements containing 6 per cent. of iron oxide show unusually small volume changes of less than 0.05 per cent. expansion after eight years in water.

Although the ageing of cement is a time honoured method of improving bad behaviour in regard to abnormal expansion, ageing has no effect upon the

ordinary expansion and contraction which have been referred to as due to the colloidal nature of the cement. For example, a cement in which 5 per cent. of coarse calcite had been added to the raw materials (for the purpose of producing free uncombined lime in the finished cement) showed an expansion of 0.295 per cent. in bars immersed in water for one month, increasing to 0.4 per cent. in a year, but thereafter there was no further appreciable movement; thus it is evident that an unsound cement is liable to show all its expansion within a period of a year, although in one case a bar made from an unsound cement expanded by 1.17 per cent. after nine months in air, suggesting that the slow hydration of the free lime in the air caused more marked expansion than the hydration of lime in water. The clinker from which this unsound cement was produced, after weathering for four months, yielded a cement which behaved quite normally in regard to expansion and contraction in the course of years.

When considering investigations of this nature which were initiated in the early days of the present century it is necessary to remember that commercial cements of that period had a decidely lower standard of quality than those of to-day. Modern cements are manufactured with greater care and with more accurate mixing and chemical composition. If, therefore, as the investigations show, the accelerated soundness tests were a proper safeguard of stability of the older cements the safeguard as applied to modern cements is still more valuable. The suggestions that have been made of high pressure steam tests or autoclave tests are not only unnecessary, but may tend to restrict the development of Portland cement in other directions. The only exception is in connection with magnesia content, but this can be provided for in the chemical analysis and it appears wise to view with suspicion any cements containing lime contents approaching the upper limit of the B.S.S. ratio (2.9 molecules of lime to 1 of silica and 1 of alumina) together with proportions of magnesia approaching the 4 per cent. of the standard specification.

European Export Sales.

THE following note has appeared in several Continental newspapers:—" A Cement Export Office has been established in Denmark which is under Norwegian management and represents the most important German, Norwegian, Swedish, English, and Belgian cement manufacturers, with a total output of 50 million barrels. This bureau is to regulate the entire cement export to South America and to eliminate wasteful competition. A similar international selling office has also existed at Oslo since the New Year, its task being to regulate export to overseas countries."
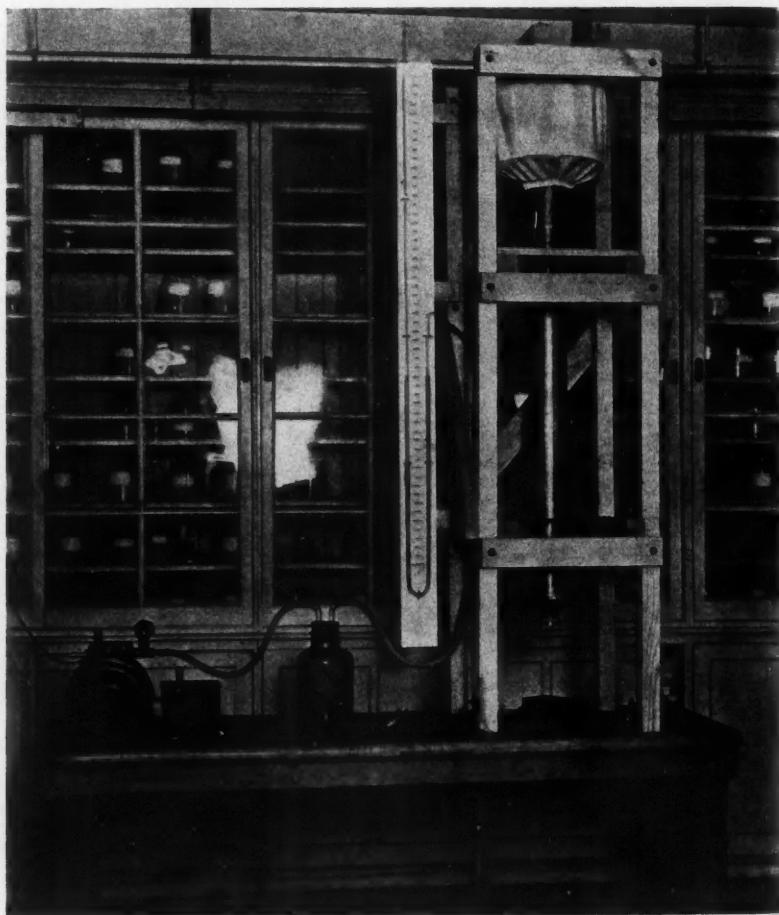
Suggested Increase in Chilian Cement Duty.

It is reported that the Chilian Government, in order to stimulate the local cement trade, is considering the gradual increase of the import duty, possibly to the extent of doubling it by the end of 1931.

Cement Flour.

STANDARD AIR ELUTRIATOR ADOPTED BY A.P.C.M., LTD.

PORTLAND cement consists essentially of silicates and aluminates of lime ground to a condition of extreme fineness. Rapid hardening cement, for example, is usually ground so finely that only about one-half of 1 per cent. is too coarse to pass a sieve having 32,400 holes per square inch, and it has long been the practice to compute the fineness, and consequently to some

Standard Elutriator.

extent the value of a cement, from the small percentage of residue retained on such a sieve.

As with all ground materials, however, the particles comprising the powder vary in size over a relatively wide range, and the real physical condition of the finely-ground cement mentioned above may be represented as :

	Per cent.
Flour	80.0
Particles passing the 200² sieve	18.5
Particles retained on 200² sieve, but passing 180²	1.0
Particles retained on 180²	0.5
	100.0

The first fraction represents the only particles that are immediately hydraulically active when gauged with water. The second fraction, although so fine that the whole of it passes through a sieve with 40,000 holes to the square inch, is yet composed of small particles of grit which may hydrate after a time but add nothing to the strength of the cement at short dates. The residues on the 200² and 180² are not only slow in their activity but their proportions bear no relation to the flour present. Hence the percentage of residue on a sieve is no measure either of the true fineness or of the value of the cement as a constructional material.

The strength of Portland cement is greatly dependent upon the proportion of the finest particles or flour, and the only rational method of judging the degree of fineness to which it has been ground is one based on the proportion of flour present.

Various machines for determining the percentage of flour have been in use for some years, but they are all quite arbitrary and the " flour " is not the same in proportion or particle size in any two of them. Many of these machines depend in principle upon air elutriation of the particles, but the quantity of material lifted by an air stream is governed by the size and weight of the particles and the velocity of the air. As the instruments referred to work at different and generally unknown velocities, the percentage of " flour " is merely that portion of the cement that happens to be elutriated in the particular machine. For example, a sample of cement tested under standard conditions by two different flourometers contained 79.5 per cent. of " flour " by one machine and 71.0 per cent. by the other.
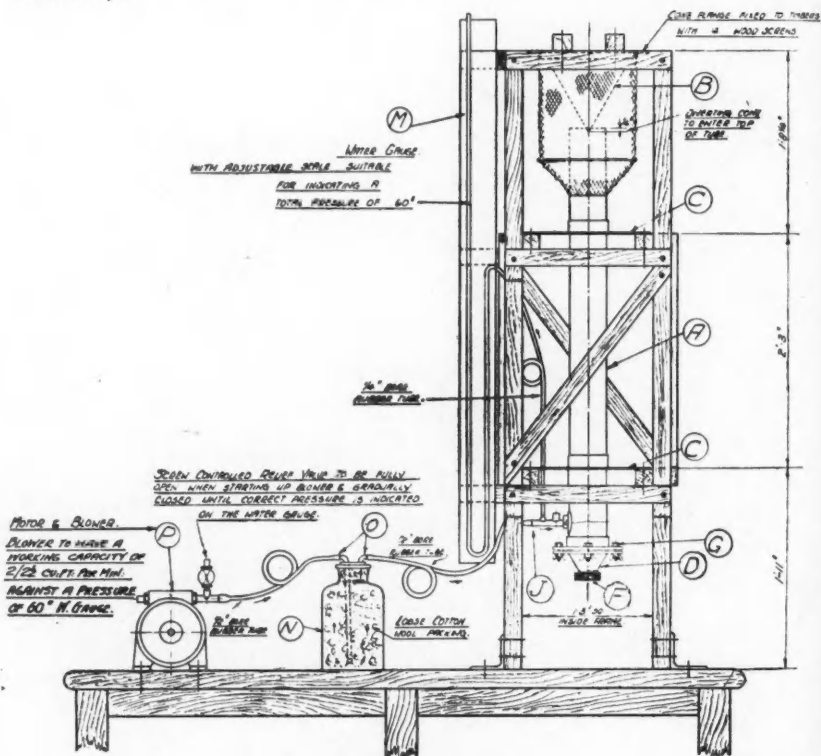
The Associated Portland Cement Manufacturers, Ltd., have adopted a " standard flour " in cement as the material elutriated by air at a definite velocity of 21 ft. per minute. The average particle diameter of this standard cement flour is approximately 0.01 mm., and is always the same if elutriated at a velocity of 21 ft. per minute. The quantity of the material elutriated at this velocity is a direct measure of the fineness of the cement, and partially of its hydraulic value. Hence a direct comparison can be made of cements of different makes.

The standard elutriator now in use at the factories of the Associated Portland Cement Manufacturers, Ltd., is of the down-blast type, the air under

B

pressure blowing into the apex of an inverted cone, thus agitating and separating the particles as well as maintaining a steady upward velocity in the elutriating tube.

The apparatus consists of a brass tube (A) 4 ft. long and 4 in. internal diameter, closed at the lower end by an airtight-fitting machined brass cone (D) with renewable steel apex plate. The tube is mounted in a suitable stand carrying a manometer and a deflecting cone (B), the point of which projects $\frac{1}{4}$ in. into the mouth of the tube (A). The upper rim of this cone is formed to carry a flannel bag or filter to retain the fine dust elutriated.

Air is blown into the apparatus from a small motor blower (P) through an oil trap (O) and a nozzle (J, H) which enters the elutriating tube near the bottom, and, bending downwards through the centre of the tube, terminates with a $\frac{1}{8}$-in. diameter jet inside the bottom cone (D). The air-inlet tube is provided with a tubulure for attachment to the manometer, and an adjusting screw (K) for calibration purposes. Once calibrated, the screw (K) is hermetically sealed and not afterwards disturbed unless re-calibration becomes necessary.
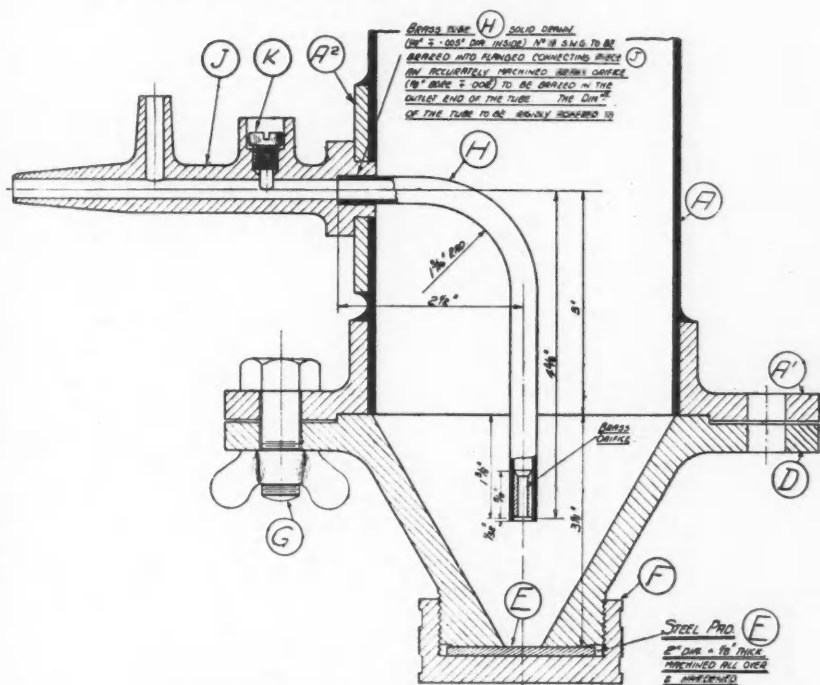

General Arrangement.

The rotary blower is fitted with a relief orifice controlled by a wheel valve, the adjustment of which enables a constant pressure to be maintained in the manometer. Jigs are provided to ensure that the nozzle and jet are assembled truly central in the elutriating tube and cone.

The test is made by placing 33.3 grams of the cement to be examined in the bottom cone, which is securely fixed to the elutriating tube by means of the wing nuts (G). A machined recess in the base of the tube enables an air-tight fit to be made without the use of rubber or other washers. The relief valve being fully open, the motor is started and the valve gradually closed until the difference in level in the two limbs of the manometer is 41.5 inches. Blowing at this pressure is continued for 25 minutes, when the motor is stopped and the cone detached from the stack. The residue in the cone, which should be dark-coloured clean grit and free from dust, is brushed out and weighed. The difference between this weight and the 33.3 grams of cement taken for the experiment represents the weight of flour removed by the operation.

Provided the pressure is maintained at 41.5 inches of water the air velocity in the elutriating tube remains at 21 ft. per minute, at which velocity standard flour is carried over.

Certain precautions are necessary for accurate work:

Arrangement of Air Inlet and Bottom Cone.

(1) The test should be made in a room with a reasonably dry atmosphere and of equable temperature. Cement flour has a great affinity for moisture, and damp air may cause the flour to stick in the tube or clog the filter. If the room is hot at one time and cold at another the accuracy of the results will be affected owing to variations in the volume of air in the elutriating tube.

(2) Flour should not be left long in the flannel filter. The filter should be emptied and shaken at least daily.

(3) With very fine cement containing 80 per cent. or more of standard flour it is generally advisable to tap the tube and cone occasionally during the operation to assist the air stream in agitating and separating the particles. It is also necessary to tap the tube before beginning a test to ensure that no flour from a previous test is adhering to it.

(4) Care must be taken that the nozzle and jet are not damaged or displaced from the central position in the cone.

With these precautions the instrument is capable of giving results to 0.5 per cent. or less in the hands of different operators.

Proposed New Kent Cement Works.

According to a Kentish paper, there has been a hitch in the proposal of the Kent colliery interests to manufacture cement at East Cliff, Dover. It is stated that a provisional agreement was made between Mr. Tilden Smith and the Dover Harbour Board, but when the actual agreement was submitted to the Dover Harbour Board it was so different from that agreed that it cannot be ratified, as it is outside the power of the Dover Harbour Board to do so.

New Cement Works in Rutland.

The Ketton Portland Cement Co., Ltd., inform us that their factory at Ketton, Rutland, is rapidly nearing completion, and that manufacture will commence in July. The works will have a capacity of 60,000 tons a year. Raw materials will be Ketton oolitic limestone and local clays, of which large supplies are available on an estate of 1,174 acres. The company is controlled by Messrs. Thos. W. Ward, Ltd., of Sheffield.

Cement Industry for Cumberland.

It is reported that the Coltness Iron Company has taken an option on the Wandhull Quarry, near Gilcrux, West Cumberland, with a view to establishing a cement manufacturing industry. It is stated that a limestone and shale are available in abundance and are of good analysis.

Cement Production in Finland.

IN our March number we gave the production figures of the Lojo and Pargas cement factories in Finland. As stated in our February number (page 44) the 1928 output of the Pargas works was 1,150,000 casks and the Lojo works 425,000 casks. A new kiln has been installed at the Lojo works, bringing the capacity up to 650,000 barrels this year, while further plant is being installed to bring the ultimate capacity up to 1,100,000 barrels.

Crushers in Cement Works.

CRUSHERS are probably more generally used than any other type of machine in the manufacture of Portland cement. They are used for the reduction of all kinds of raw material, including gypsum, coal, and cement clinker. Each type of machine possesses its own specific characteristic, and these specialities should be considered and taken advantage of in selecting machines for any particular duty.

Some machines function only 50 per cent. and others 100 per cent. of their running time. The most efficient reduction ratio of most types of machine is $3\frac{1}{2}$ or $4\frac{1}{2}$ to 1. The similar ratio of at least one other type of machine is practically unlimited. Some machines produce fines, other machines effect a definite reduction upon the whole of the material that pass through them; again, other machines effect no reduction on the under-size passing through them.

The chart shown in Fig. 1 indicates two distinct characteristics of crushing machines. One characteristic is indicated by the straight lines, another by the curved lines. The straight lines show the reduction and usual classification of the product of jaw-type crushers and gyratory-type crushers. It may be stated that the product classification of these two machines is identical, and, further, that 15 per cent. of each product is of rather greater dimension than the " ring " size of the machine setting; this is due to the " slabby " or cubical nature of the product. If either of these two types of machine is fed at a low rate the product will be of a larger general size than if the machines were fed at a crowded rate.

The product characteristic of the hammer-type crusher is entirely different from that of the jaw and gyratory types, and, as may be seen, takes the form of a curve. It will be noted also that the size of the largest piece is decidedly less than that of the setting (grid opening) of the machine. A very important characteristic of the hammer-type machine is its capacity to produce " fines." Owing to the large quantity of fines produced this machine makes an ideal reduction unit for breaking down the raw material for the feed of any mill; moreover, there is no reasonable limit to the reduction ratio of some types of this machine.

A consistently regular feed is probably the most important essential for the satisfactory operation of any and every type of crusher. It is not sufficient to build a large hopper over the crusher mouth and expect it to function satisfactorily. A hopper of this type will not function, the feed will not be regular, the crusher will be either choked or starved. A hopper is necessary, but it should be built remote from the crusher and a feeder interposed between the two units. If there is any possibility of tramp iron being mixed with the feed a magnetic separator of some kind should also be installed in the circuit.

A description of the types of machines in most general use and their characteristics is as follows :—
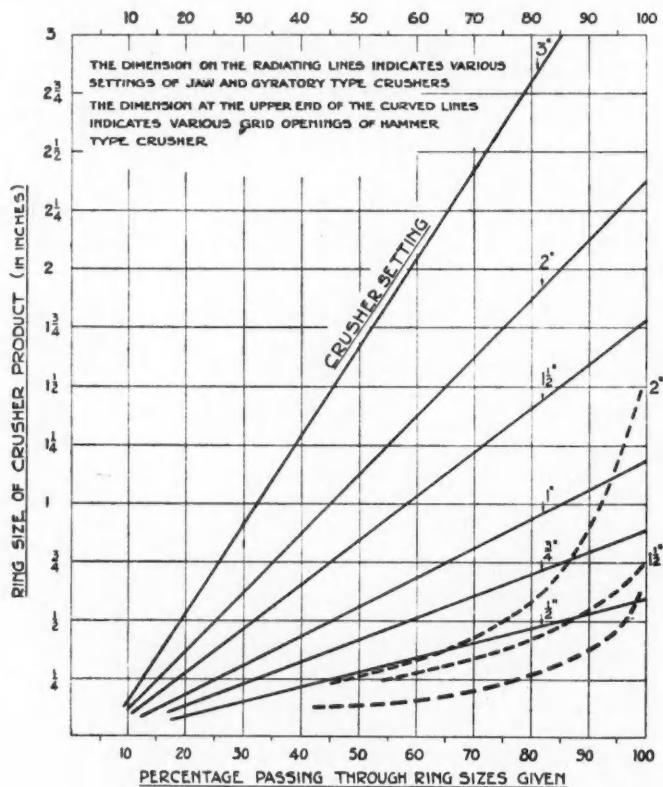
Jaw Crusher.

This type of machine is probably the oldest member of the crusher family. It is made in several types, and effects crushing by means of a swinging jaw or

jaws which move towards and away from a fixed jaw.   The jaw movement is produced by an eccentric spindle or crank spindle operating through a toggle joint at an enormous mechanical advantage.   The framing of the smaller size machine is usually a one-piece iron casting, but the framing of the larger machine is usually of the built-up type and of steel castings.   The largest machine yet made has a jaw opening of about 7 ft. 6 in. or 8 ft. by 5 ft. 6 in. or 6 ft.

The jaw crusher functions about 50 per cent. of its running time.   It is very suitable for dealing with hard, dry, crystalline and non-clogging material.   It is hardly suitable for gypsum or similar material of a tough nature.

The most efficient reduction ratio of the jaw crusher is 4 or $4\frac{1}{2}$ to 1.   The size capacity of this unit is of the same order as its quantity capacity.   A definite relation should exist between the pitch of the corrugations in the jaw face and

THE DIMENSION ON THE RADIATING LINES INDICATES VARIOUS SETTINGS OF JAW AND GYRATORY TYPE CRUSHERS

THE DIMENSION AT THE UPPER END OF THE CURVED LINES INDICATES VARIOUS GRID OPENINGS OF HAMMER TYPE CRUSHER

CRUSHER SETTING

RING SIZE OF CRUSHER PRODUCT (IN INCHES)
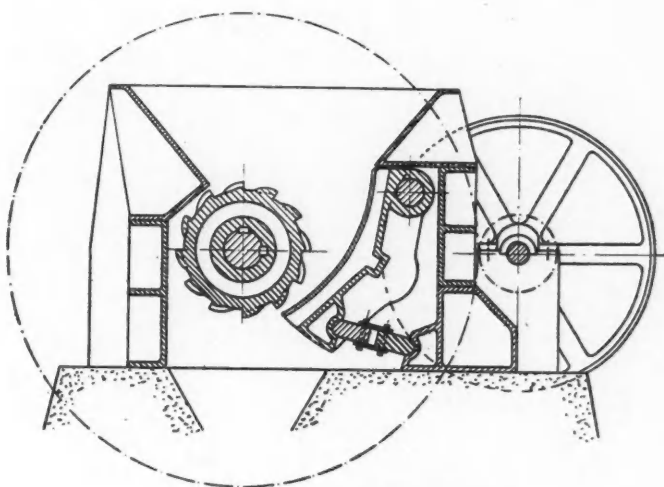
PERCENTAGE PASSING THROUGH RING SIZES GIVEN

Fig. 1.

Fig. 2.—Single Roll Crusher.

the ring size of the product. Vee corrugations and ridges are most suitable for the materials this type of machine will deal with.

Owing to its relatively large mouth opening the jaw-type crusher is a very useful and an entirely suitable machine for the initial breaking down of large pieces of stone and rock. The classification of the product will be as indicated by the straight lines on the chart (Fig. 1). The largest dimensions of the product, however, will be about one-fourth or one-fifth of the original dimensions of the largest pieces. Where secondary crushing is necessary, final classification will be determined by the secondary or final machine.

Gyratory Machine.

This machine is of more modern type and construction. It functions 100 per cent. of its running time. It is larger, more costly, and less suitable as a breaking-down machine than the jaw crusher. It is suitable for all the materials enumerated above, and much more suitable for gypsum than the jaw-type machine. When used for gypsum the crushing surface should be of semicircular or corrugated section instead of the more usual vee section. An efficient reduction ratio of this machine is also one-fourth or one-fifth. The quantity capacity is relatively greater than the similar quantity capacity of the jaw machine, though the size capacity is less. The vertical height of this unit is much greater than the similar height of the jaw machine of similar capacity. The classification of the product would be similar to that of the jaw machine, and generally as indicated by the straight lines on the chart (Fig. 1).

Roll Crusher.

Roll crushers are constructed in several types—-single roll, double roll, smooth surface and corrugated surface, high-speed roll, slow-speed gear-driven rolls, etc. This type of machine is being used for every duty that the details of construction make it suitable for and justifies.

The single-roll slow-speed gear-driven machine is being adopted largely in the United States for breaking down limestone and similar raw material. One
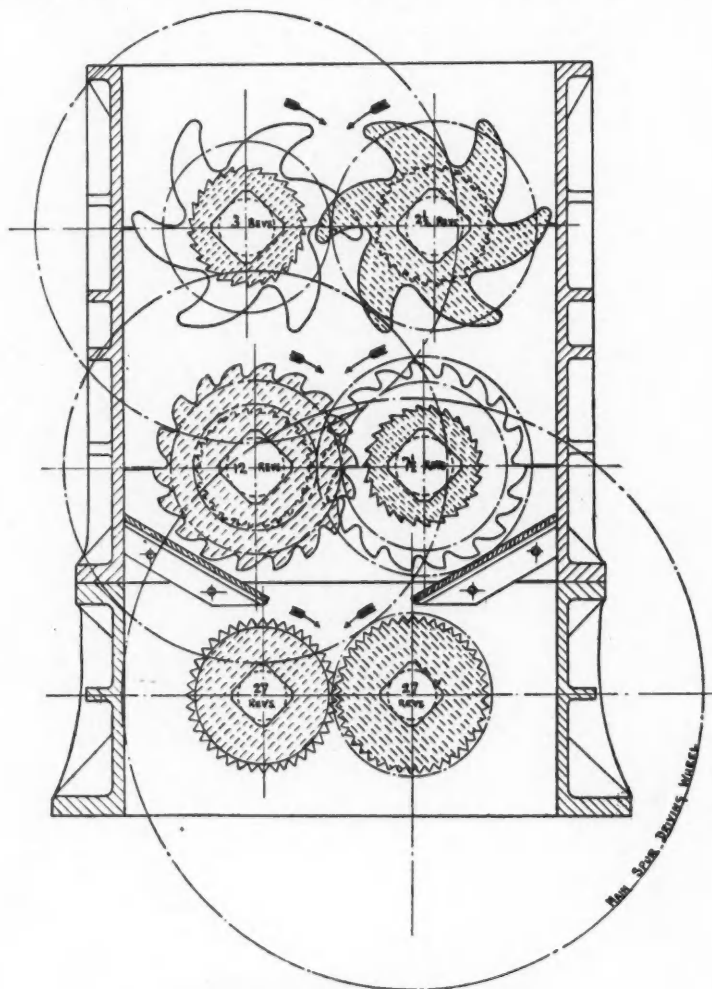
Fig. 3.—Six Roll Coal Crusher.

such machine recently constructed has a capacity of 350 to 400 tons per hour. The dimensions of the feed may be as great as 3-ft. cube and the discharge product 6 in. cube or even less.   This machine requires a 400 to 450 B.H.P. motor to drive it.

In this type of machine crushing is effected by the tooth, serrated or corrugated surface of the slow-speed roll feeding and crushing the material against a fixed jaw incorporated in the machine framing.   The machine is an extraordinarily strongly-constructed unit, and its reduction ratio is larger than either the former machines.   The quantity capacity is also large.   A sectional illustration, diagrammatic, of a machine of this type is given in Fig. 2.

Double-roll machines with a slightly corrugated or serrated surface, operating at high speed, are sometimes used for reducing oversize pieces of limestone, shale, etc., for mill feed.   For this particular duty the whole of the mill feed could be passed through the rollers on the way to the mill, but the oversize pieces only would be broken down.   The duty of the rolls appears small, but the advantage so far as the mill is concerned is most marked.

When the machine is specially installed for reducing " oversize " an advantage would result if the fines were short-circuited, thus preventing undue wear on the surface of the rollers.   The efficient reduction ratio of any two-roll machines having comparatively smooth surfaces can never be greater than about 3 to 1.   If the surfaces are corrugated the reduction ratio may be rather larger.

Double-roll, slow-speed crushers are also used for dealing with coal used in rotary kilns, and crushing in this case is effected with the object of producing a feed suitable for the coal-grinding mills.   In Fig. 3 such a machine is shown built up of three pairs of roll shafts, each shaft being fitted with tooth-type discs to form the rolls.   These discs are relatively narrow or thin, and the distance-pieces between adjacent discs take the form of another disc of smaller diameter and having a very finely-serrated surface.   On referring to the illustration it will be noted that the teeth in the upper part of the rolls are much coarser and of much larger pitch than in the lower.   In the intermediate part the teeth are of intermediate size, and in the lower of a comparatively fine order.   Where coal of a relatively small size is procurable, only the lower rolls would be necessary; where the coal is of a larger size, a second pair of rolls is necessary; a further pair of rolls would be necessary when operating with occasional lumpy coal.

This type of machine is usually belt-driven through a train of gears.   In the illustration the pitch lines of the gears are indicated by chain-dotted lines.   It will be noted that the separate shafts of each of the first two pairs rotate at different speeds; the lower pair rotate at the same speed.   As coal is a comparatively non-abrasive material there is no objection to the undersize passing through the rolls with pieces which require crushing.   The classification shown by the straight lines in the graph (Fig. 1) would apply generally to the product of a machine of this type also.   Probably 15 per cent. of the product would exceed the ring size dimension of the setting of the lower pair of rolls.   The power required for a unit of this kind would be relatively small, say, $1\frac{1}{4}$ or $1\frac{1}{2}$ B.H.P. per ton; this figure would probably be sufficient for the three pairs.   If

the coal were relatively fine, and the lower rolls alone required, the power figure obviously would be much less.   As a matter of fact the friction absorbed in rotating the rolls would be very much greater than the power necessary for crushing.   A very safe figure would be 0.7 to 0.8 B.H.P. per ton crushed.

Hammer-type Crushers.

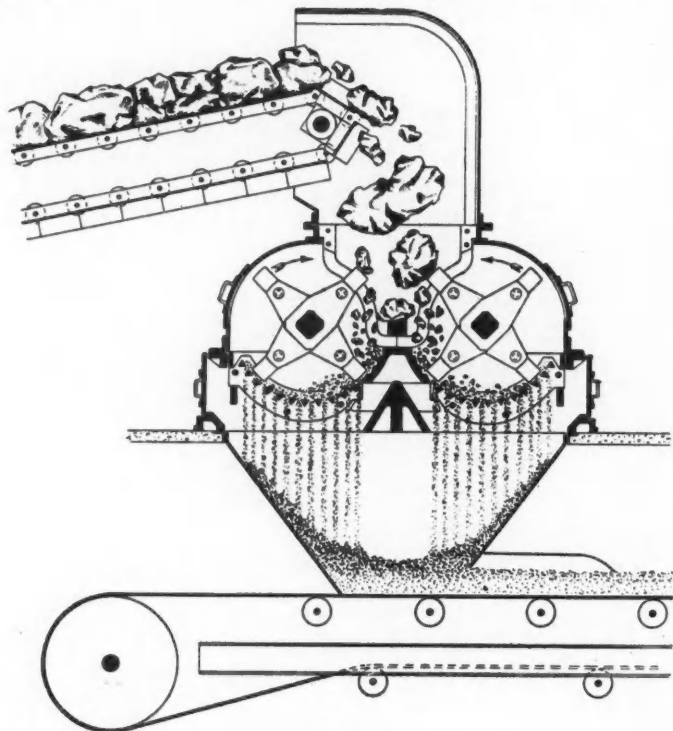These machines are made with either a single spindle or a double spindle. Single-spindle machines are most generally used in this country ; double-spindle

Fig. 4.

machines are used universally on the Continent and largely in America.   Single-spindle machines, however, are also used in America.

The reduction ratio of the single-spindle machines as built and used in this country is comparatively small owing to the restricted dimensions of the mouth opening.   The reduction ratio of the machine built and used in America and on the Continent is large, almost unlimited.   These machines will accept as feed whatever size pieces will enter the mouth of the machine and discharge a product of predetermined maximum ring size.   The dimensions of the space between

the grid bars does not appear decisively to affect the ring size of the product. As the movement of the hammers is transverse to the length of the grid opening, the material passed through is consistently smaller than the space. An examination of the curved lines in Fig. 1 will make this clear.

Double-spindle machines are used on the Continent for reducing limestone from quarried sizes, say, 36 in. by 24 in. by 12 in. :—down to, say, 1 in. or $1\frac{1}{4}$ in. ring size suitable for feed for a dryer or for the raw-grinding mills. Similar machines are used in the United States for the same duty.

English type machines of small size are largely used in the limestone quarries of North Wales and Derbyshire for the further reduction of comparatively small limestone, especially when fines are required.

Fig. 4 shows a diagrammatic and typical section through a double-spindle machine, the difference in size of the feed and discharge is characteristic of this machine. The same illustration indicates a slat or tray type conveyor feeder
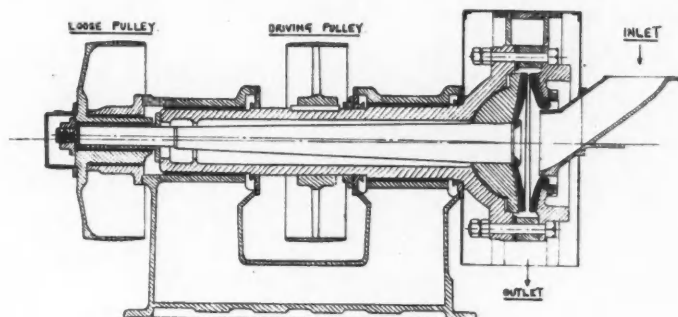

Fig. 5.—Disc Crusher.

operating in conjunction with it. The feeder performs an important part in the operation of hammer-type crushers; as a matter of fact this type of crusher would not function satisfactorily without a suitable feeder.

Disc Crusher.

This machine is made in the horizontal type in England by Hadfields and in the vertical type by the Simons Company of America. A diagrammatic section of the horizontal machine is shown at Fig. 5. This type of machine functions 100 per cent. of its running time. Its reduction ratio is comparatively small, viz. $3\frac{1}{2}$ or even 3 to 1. The characteristic of this machine is that it reduces the oversize to the ring size predetermined by the initial setting of the machine without further reducing those pieces which are already down to the ring size. This machine definitely produces " gravel," and not " fines," and is suitable for this purpose. Crushing is effected by a heavy compressive pressure exerted by and between two smooth, dished, or concave surfaces. This pressure is caused

by the pendulum like movement of the end of the spindle, caused in turn, by the eccentricity of the bore of the pulley.   The crushing surface is large in both types of machine, and extended working life is obtained without renewal of wearing parts.

Briefly reviewing the types and characteristics of the machines referred to, it may be said generally that the jaw, roll, gyratory, and disc type machines reduce the input to the general size determined by the initial setting of the machine, and apart from the characteristics and structure of the material; the tendency to reduce below this size is small.   The hammer-type machine produces a large amount of fines.   The tendency of this machine is to reduce the size of every piece of material which passes through it; at the same time nothing can get out until it reaches the predetermined size.   This maximum size or dimension is determined generally by the dimension of the space between the grid bars, but the percentage of material considerably below this size will be very large.

In conclusion, it may again be said that too great importance cannot be attached to the provision of a suitable feeder for every type of machine.   This feeder should be positioned immediately beneath the storage hopper, and its speed should be controllable so as to enable the crusher to work at a maximum duty without any tendency to " choke " or " starve " under any set of reasonable conditions.

Sales Control in Poland.

We understand that the " Centro-Zement " is taking over the activities of the Polski Cement Export, which was the organisation dealing entirely with the export side of the Polish cement sales.   In future " Centro-Zement " will conduct sales for the whole of Poland, both for export and the home markets.
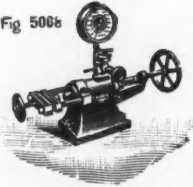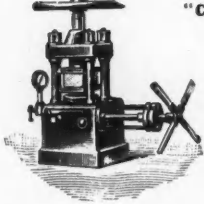
A Modern Pulveriser.

PULVERISED fuel has been used in the cement industry since 1900, and various methods of preparing the pulverised product have been employed.   It is only natural that in the earliest installations the methods of grinding and collection used for cement practice were followed.   With the development of pulverised coal firing newer methods of preparation have come to the fore, and the " Atritor " unit pulveriser is the outcome of much experimental work in this direction.   The " Atritor " pulveriser, at one operation, feeds, removes tramp metal, dries, pulverises and fires the product, and is claimed to fulfil successfully all the important conditions required for firing a cement kiln; these are (1) reliability and simplicity of operation, (2) uniformity of the ground product, (3) constant velocity of injection into the kiln, so that a combustion zone is kept at the right place in the kiln's length.

Fig. 1 shows a section of the " Atritor " pulveriser from which the operation of the machine will be understood.   Raw coal is fed from the bunker into the hopper, the rate of feed being governed by the feeder of the rotating-table type. The coal spreads over the disc and the required amount is cut off by a stationary knife.   The thickness of the coal on the disc is regulated by a sleeve surrounding the base of the hopper, and which can be set at any desired height above the disc.

As the coal is scraped from the feeder-disc it falls through what is termed the " metal separator "; at this point the falling coal is met by an upward stream of air induced by the fan of the machine.   Coal is drawn into the pulverising chamber, but any foreign material such as tramp metal or stone continues to fall under the action of gravity and passes out through the tramp-metal chute at the base of the machine.

The coal is pulverised in two stages, called the first and second effect.   The pulverising chamber is divided by the rotor disc carried on a hub keyed to the main shaft.   The usual arrangement of the pulverising elements is as follows. In the first effect are six hammers freely pivoted to the hub that carries the disc. They are surrounded by a perforated screen-ring made in four segments and fixed to a steel plate bolted to the body of the machine.   When the machine is running the hammers are held out by centrifugal force, and clear the screen by about $\frac{1}{4}$ inch.   The incoming coal is caught and beaten through the holes in the screen-ring, being thus reduced to a rather coarse granulated form.

The air stream carries the granulated coal round the edge of the disc into the second effect, where the fine grinding is done.   The pulverising chamber is separated from the fan chamber by a diaphragm, in the centre of which is a hole through which the coal dust and air have to pass.   The air drift in the second effect is therefore from the outside to the centre, a fact that has much to do with the successful working of the machine.

The pulverising elements in the second effect consist of alternate rings or inter-rupters, fastened in the rotor disc and in a plate bolted to the diaphragm re-spectively.   The fixed pegs overlap the moving pegs, and there is a clearance of

about ½ inch between the two.   The moving pegs are travelling at high speed through a cloud of coal dust, which is prevented from swirling round with the disc by the fixed pegs.   Violent vortices and eddies are set up, and the attrition of the coal particles on each other reduces the coal to an impalpable powder. The fact that the machine pulverises by attrition gave rise to the name " Atritor.''

Since the machine depends for its pulverising action upon the air currents created by the moving pegs, and not on fine clearances or pressure between two surfaces, so long as there is enough of the pegs left to create air currents the same degree of fineness will be maintained.   Moreover, the opposing forces acting on the coal particles due to the pull of the air towards the centre and the centrifugal force towards the outside ensure that practically all the coal is pul-
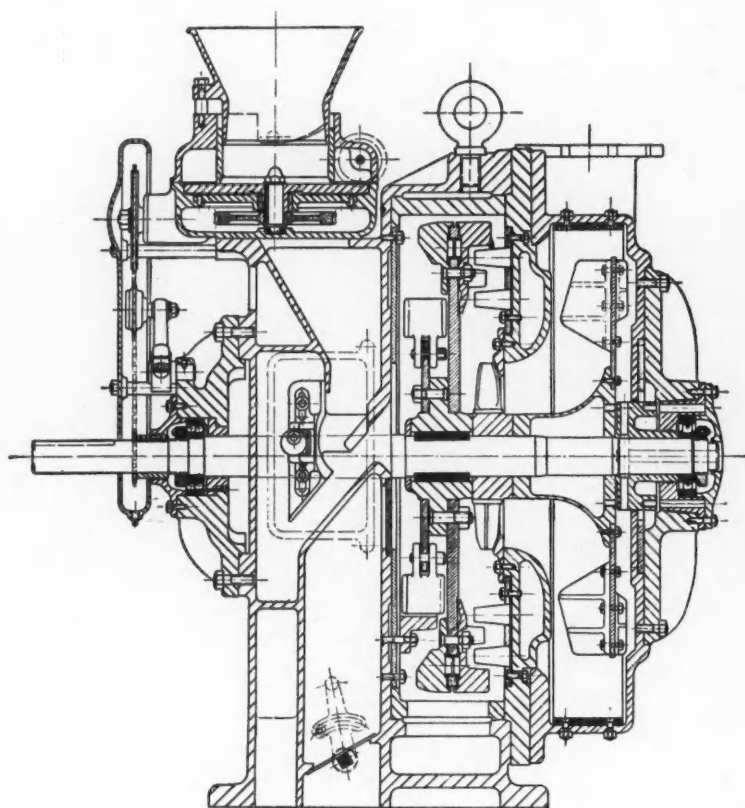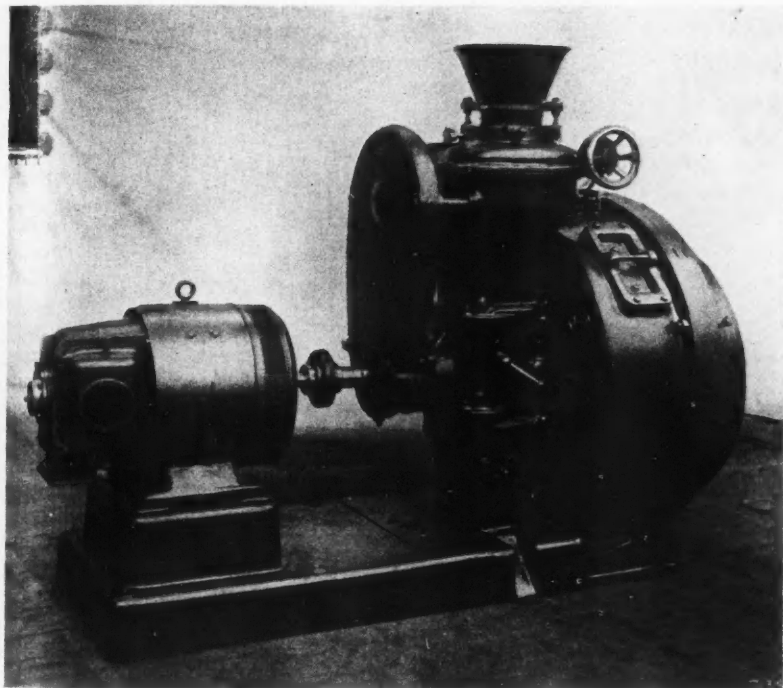

Fig. 1.

verised to the required degree of fineness before the air drift overcomes the centrifugal force and carries the coal down to the centre.

The coal is dried during pulverisation by hot air admitted to the grinding chamber in the first effect through the inlet just below the shaft. At any instant there is only a small quantity of coal in the machine, and this is in suspension in turbulent air currents. There is therefore a very large surface of the coal exposed to the drying action, and moisture is driven off at once. It is found in practice that any coal not too wet to be fed successfully into the pulveriser can

The " Atritor " Pulveriser.

be dried and pulverised without difficulty. Should a small piece of metal or stone pass the separator, it is trapped in a pocket in the bottom of the pulverising chamber. This extra safeguard effectually prevents anything that may damage the pegs passing through to the second effect.

From the second effect the coal is drawn through the rejector into the fan casing. The rejector consists of a number of arms fixed to the fan hub, and the coal particles have to cross the path of these arms. In the air stream the larger particles are travelling more slowly than the fine dust, and before they

have time to pass they are caught and flung back among the pegs for further pulverisation.   By altering the number of arms the fineness to which the " Atritor " pulverises the coal can be altered.   Thus it is possible to set the machine to grind the coal to a fineness suited to each individual application and the class of fuel being used.

The fan is fitted with small auxiliary blades on the outside of the fan-plate. By opening a slide on the outside of the fan-casing additional air is drawn in by the auxiliary blades and discharged with the coal and air that pass through the machine.   At full load about 30 per cent. of the total air necessary for combustion is discharged with the coal by the main fan, and this quantity is increased to about 40 per cent. by opening the auxiliary air-inlet.

Since its inception the " Atritor " has undergone many changes in design, but the principle of pulverisation by attrition has been retained.   The improvements fall into two main sections : (1) improving the life of the wearing parts, (2) improving the accessibility of such parts.   The early machines were capable of grinding from 300 to 500 tons of coal before requiring replacement of the pulverising elements.   A life of ten times this quantity is now obtained.

A step forward in the development of the " Atritor " was made when the hinge construction was adopted.   By this device the " Atritor " can be swung open in much the same way as a watch and the interior made accessible, thus all lifting of heavy parts with the consequent danger and loss of time has been eliminated.   It is now possible to open up, renew the pulverising elements, and have the machine back in operation within a couple of hours.   Due to the basic principle underlying the method of pulverisation in the second effect, fine grinding is obtained, and this is maintained during the working life of the pulverising media.   The power consumption of the machine is therefore low.

The early machines were put into service for the firing of cement kilns, and from their inception have proved that they are capable of grinding coal to the somewhat stringent requirements of that industry; they are undoubtedly cheaper to operate than the usual storage type of plant and do not involve great complexities.   The hot air for drying purposes is usually drawn from the clinker cooler; this device cuts out the large unwieldy and in many cases totally unsatisfactory coal drying plant.

Proposed Australian Developments.

At the recent annual general meeting of the National Portland Cement Company the directors stated that they had found a suitable site north-east of Port Fairy, and proposed the establishment there of a new plant at a cost of £200,000.

The " Sydney Daily Telegraph " reports that the erection of a cement works is proposed at Port Kembla.

New Belgian Cement Works.

" Cimenteries Delwart S.A." is the name of a new cement plant to be erected at Saint-Maur, lez Tournai, with a capital of $7\frac{1}{2}$ million francs.

Burning in Cement Kilns.

By F. E. SCHMITT, A.M.I.Mech.E.

AN article on " Fundamentals of Portland Cement Manufacture " in the November number of " Cement and Cement Manufacture " contained the following sentence: " The bugbear of clinker-rings and their disastrous effect upon continuity of kiln operation is also related to coal quality and fineness, and needs to be considered in connection therewith."

The clinker-ring is certainly a bad handicap if it recurs frequently. One of the main reasons for its formation rests upon coal quality and fineness. Ash from poor coal or ash from coal not sufficiently ground may quickly lead to the formation of a deposit on the kiln-lining from which a ring may develop. Another cause may be due to raw materials which have a low clinkering tem-
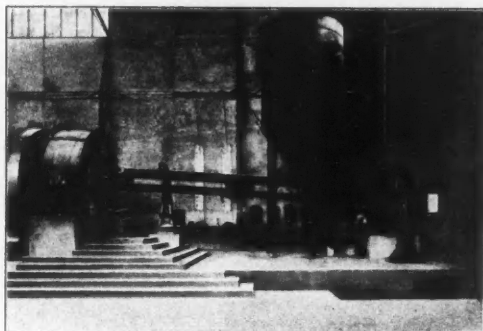

Fig. 1.

perature, or whose clinkering temperature and fusing or melting temperature are nearly the same.

In some cases the quality of coal is not a matter of choice and the clinkering temperature of the raw materials may also have to be accepted. The close proximity of the clinkering and melting temperature, generally caused by the presence of a flux such as iron, alkali, magnesia, and the like, can be counteracted under certain conditions. The fineness of the coal burnt is merely a matter of grinding.

But in some extreme cases clinker rings cannot be avoided. The next best thing to not having rings is to get rid of them as quickly and with as little trouble as possible. The usual method is by means of a long steel bar, which is used as a kind of poker. Water-jets and guns have also been used, but any method of this nature will necessitate a stoppage of the kiln.

A very neat and convenient method has been developed with the Solo-rotary kiln—a kiln with cooler in one piece—which is also used with ordinary rotary kilns with separate coolers. This is a long burner-pipe which can be moved

backwards and forwards in and out of the kiln for a certain distance. The maximum distance allowed by the makers is about 16 ft. In other words, the mouth of the burner and the flame can be moved for this distance farther up or down the kiln. When a clinker ring has formed in the kiln the burner-pipe is moved along so that the section which was sufficiently hot to allow the building up of a ring is now cooled down. This decrease in temperature will bring with it a contraction in the mass of the ring, and consequently a breaking up and collapse. When this has happened the burner-pipe and flame are brought back to their original position until the formation of a new ring calls for further action.

This contrivance, which has been proved with the most difficult raw materials, is really a very simple affair, but it calls for ample room on the burner plat-form as will be seen from Fig. 1, which shows the outlet or firing end of a Solo kiln. The long burner-pipe, partially outside the kiln, with its support and
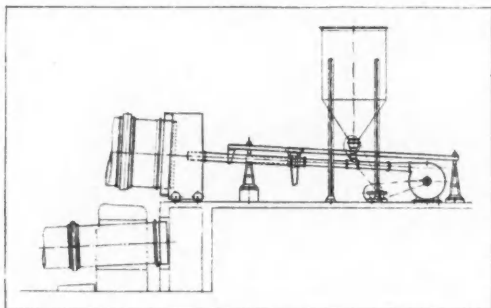

Fig. 2.

trolley, are visible. Fig. 2, which shows how the burner can be used with a kiln with a separate cooler, will make it clear how the burner pipe travels back-wards and forwards over a concentric pipe. Easy movement is obtained by means of a hand wheel and chain.

With a burner of this kind it has been found possible to keep the kiln absolutely clear of rings without stoppage, although the moving of the burner, and with it the hottest section of the kiln, causes a certain irregularity in the kiln output. This does not, however, affect the quality of the clinker, and in the long run the output with this type of burner is higher in proportion to the time lost by stoppage with the older method. It might be mentioned that experience shows that the burner-pipe must be able to be moved for at least 9 ft. in order to allow for a sufficient difference in temperature.

Apart from the treatment of clinker rings, this type of burner, owing to the length of kiln served, has marked advantages when the so-called coating of the kiln lining is being formed, as this coating is of great importance to the life of the lining.

Tests for Proportioning Raw Materials for Portland Cement.

By A. C. DAVIS, M.I.Mech.E., M.Inst.C.E.I., F.C.S.

(*Works Managing Director, Associated Portland Cement Manufacturers, Ltd.*)

THE thoroughness of the mixing and grinding of the raw materials for Portland cement manufacture exerts an immense influence on the quality of the cement produced. Cements made from raw materials which have been correctly proportioned and ground to extreme fineness show high strains, especially at short periods, and have quick hardening properties. The two methods in general use for keeping a constant check on the accuracy of the mixing of raw materials are :—   (1) By the calcimeter.
          (2) By titration.

Calcimeters.—As there are many calcimeters in use a description of two of these instruments will be sufficient, namely, Faija's compensated apparatus, and Scheibler's calcimeter both used for the volumetric estimation of calcium carbonate by the measurement of carbon dioxide gas evolved. These are illustrated in Figs. 1 and 2 and act by the direct gas method, in which the carbonate of lime is decomposed by acid and the evolved carbon dioxide gas collected in a suitable apparatus and measured. The carbon dioxide bears a fixed proportion in the calcium carbonate, and the percentage of lime can be calculated from the volume of gas given off.

Faija's Instrument.—In the illustration of the Faija's instrument (Fig. 1) are indicated : A, generating bottle ; B, acid measure ; C, gutta-percha acid tube ; D, condenser with lead coil ; E, gas measuring tube, having at its upper end two taps F and G ; H, equilibrium tube, which may be moved up and down and secured in any position by fixing it on the rod I by means of the thumb-screw K ; L, barometer to which is attached on its upper side the tap M ; N, india-rubber ball attached by a tube to the barometer ; this ball may be compressed or expanded by turning the handle O, thus adjusting the pressure in the instrument.

The instrument is first secured firmly against a wall, with the tubes E and H perfectly vertical. The india-rubber tube P connects the lower ends of tubes E and H. Tube H is then lowered until its upper neck is a little above the lowest reading on tube E, a funnel inserted in the neck H, and the tube filled with water until the water rises to the lowest reading in tube E. When filling with water the two taps F and G should be open, and tube P pressed to expel any air.

Distilled water is used, and in order that all air may be expelled it should be boiled and allowed to cool before pouring into the instrument. Then attach the other india-rubber tubes, as shown in the drawing, put the stopper into the generating bottle A, close taps G and M, and see if the instrument is tight. This is ascertained by placing the equilibrium tube H in such a position that there is a difference of several inches in the level of the water in the two tubes E and H and noting the reading of the level of the water in tube E. If the instrument is tight the water will remain at this level for an indefinite period, but if the water

in E rises or falls some of the joints are not tight and they must be made tight by binding them with thin wire. The condenser D should be filled with water.

The mode of working is as follows :

First remove the cork from the generating bottle A, take out the acid tube C, then open the taps F, G, and M. Elevate tube H to such a height that the water in tube E is exactly level with the mark immediately under tap F, and secure it
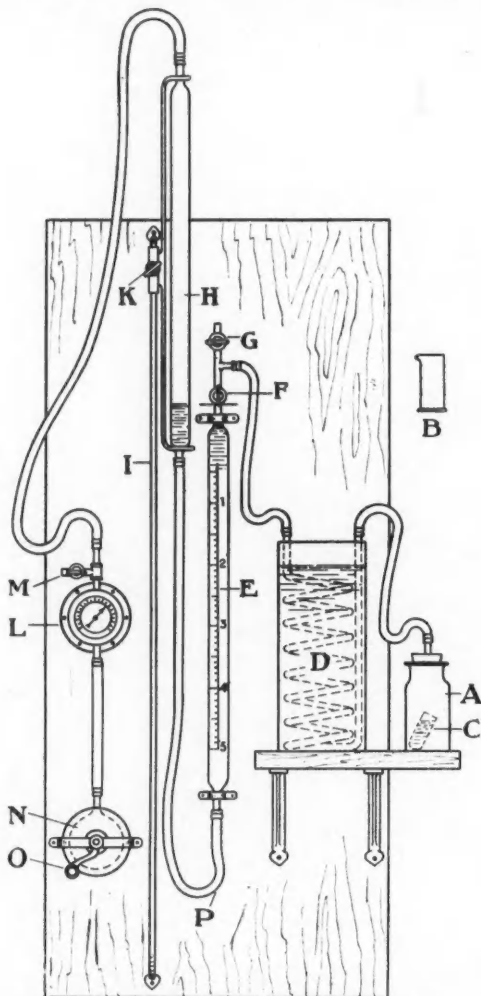

Fig. 1.—Faija's Dietrich Calcimeter.

there by turning the thumb-screw K.   Weigh out the quantity of carbonate of which it is desired to determine the carbon dioxide, and place it in the generating bottle A.

Measure out the proper quantity of acid to use in the measuring glass B and pour it into the acid tube C.   Wipe the outside of the acid tube C so as to be sure that no acid has run down the side, and insert it, with a pair of tongs, into the generating bottle A.   Re-insert the stopper in the generating bottle A, taking care that it is secure and tight.   Close tap G and slack the thumb-screw K, keeping tube H approximately in its elevated position.   Now incline the generating bottle A so that the acid runs out of the acid tube C on to the carbonate in the bottle A, and as the gas is generated lower tube H so as to keep the water in tubes E and H approximately at the same level.

Continue shaking the bottle while the gas is generating, and be sure that all the acid has run out of the acid tube C.   Place the generating bottle A in the water in the condenser D to cool the gas (which might have been heated by the handling of the generating bottle A) to the temperature of the water in the condenser D.   Having left it there for a minute or so, remove it and again shake it, and note if any more gas is generated.   When all the gas is generated (which is indicated by the water in tube E remaining in a constant position) close taps F and M, turn the handle O actuating the ball N in either one direction or the other so that the pressure in the barometer is diminished or increased until it indicates the normal pressure of 29.92 inches, or 760 millimetres, which is more distinctly shown by the heavy line.   Adjust tube H so that the water in it is exactly level with the water in tube E, and take the reading of the level of the water in tube E.   This reading is the amount of gas developed at the standard pressure and simply requires correction for temperature, which may be ascertained by tables already prepared.

When using the instrument the thermometer should be placed and left in the water in the condensing vessel D, as it is the temperature of this water which governs the temperature of the gas, but it is as well to try to adjust the temperature of the water to approximately the temperaure of the atmosphere of the room in which the instrument is worked.

Before commencing an experiment the reading of the barometer should be ascertained, and if above 29.92 inches or 760 millimetres the ball N should be deflated so that by turning the handle O and allowing the ball to expand the pressure in the barometer will be decreased.   If, on the other hand, the barometer is below 29.92 inches or 760 millimetres, the ball N should be left fully expanded, when by turning the handle O so as to compress the ball the pressure in the barometer will be increased.

The essential portion of this particular apparatus for the determination of carbon dioxide consists in the addition of a barometer to the equilibrium tube, the pressure in which, and in the gas-generating tube, may be adjusted to a standard pressure.

By this arrangement temperature is the only factor which it is necessary to consider when the volume of the gas has been ascertained by the reading of the

instrument; and for easy use complete tables have been arranged so that the operation of testing raw materials only occupies a few minutes.

Scheibler's Instrument.—Scheibler's calcimeter (Fig. 2) consists of the following parts: a small bottle A provided with a perforated stopper in which is placed a tube S, of gutta-percha or glass. Another bottle B is provided with three openings in its neck. The central opening of the bottle contains a firmly-fixed glass tube, which connects at the one end with A by means of the flexible rubber tube R and at the other (inside the bottle B) with a very light india-rubber bladder.

The left-hand opening is controlled by a pinch-cock on a piece of rubber tubing. The right-hand opening connects B with the measuring tube, which is an accurately-graduated glass cylinder C of 150 c.c. capacity. Another glass cylinder D serves to regulate the pressure of the gas measured in C; a tube P passes through a stopper into the water reservoir E and is connected with D and controlled by means of a pinch-cock.

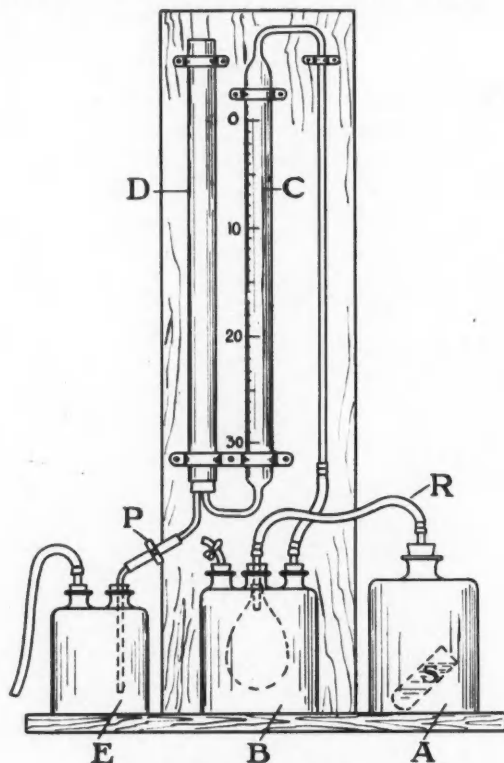A small sample of the raw material, say, 0.5 grammes, finely powdered, is

Fig. 2.—Scheibler's Calcimeter.

placed in the bottle A. The tube or cup is filled with 10 c.c. of dilute hydro-chloric acid and placed also in the bottle.

Shake the bottle A so that the acid gradually mixes with the sample, and release the cock P in order that the water which has been previously filled into the cylinders D and C may be released as the gas in C displaces the same; keep the water in D on an exact level with C. Then take the reading on C and com-pare the volume of gas given off from the sample with the results from testing a standard sample of pure calcium carbonate (Iceland spar).

For example, take 0.5 gramme pure calcium carbonate; say the gas registers 18 c.c. on the cylinder C, and say 0.5 gramme of the mixed raw materials for the manufacture gives 13 c.c. of gas. The result is $\dfrac{100 \times 13}{18} = 72.2$ per cent. of carbonate of lime in the sample.

Other methods can be adopted for estimating the carbonate of lime in raw materials, but those just described are sufficiently accurate for general practical purposes and little or no technical skill is required in their manipulation.

It should perhaps be noted that in the estimation of calcium carbonate, by either of the means here described, the carbon dioxide from any magnesium carbonate present will be measured as from calcium carbonate. The amount of magnesia is usually so small and varies by so little, however, that this can in most cases be ignored.

Titration Test.—By the titration test the calcium carbonate is decomposed by a measured quantity of standard nitric or hydrochloric acid, and the excess of acid determined by titration with standard alkali. This test necessitates the careful preparation and standardising of solutions by qualified chemists. The method is based on the chemical action of a given quantity of acid of known strength on a given weight of carbonate of lime, the excess of acid being found by titration with standard alkali. The solutions required for the titration test are normal hydrochloric acid and semi-normal sodium hydroxide.

Standard Normal Hydrochloric Acid Solution.—To prepare a Standard Normal Hydrochloric Acid (HCL) Solution take 200 c.c. of pure concentrated acid and well mix with 1800 c.c. distilled water. To standardise the solution, weigh accurately 1.06 grammes of pure dry sodium carbonate (Na_2CO_3), which should be ignited and cooled in a desiccator before weighing. Transfer to a 200 c.c. flask and dissolve in about 25 c.c. distilled water. Add two drops of methyl orange indicator, and titrate the contents with the acid solution from a graduated burette.

It will be found that it takes 20 c.c. normal standard acid to neutralise the 1.06 grammes Na_2CO_3. Should the acid be too strong, water is added; if too weak, more acid is added; but it is better to make sure of the acid being too strong as it is much quicker to dilute to standard than to raise by addition of more acid. For rapid correction the following calculation is advised :—

Example.—Acid required to neutralise 1.06 gr. Na_2CO_3 = 19.2 c.c. As stan-dard acid takes 20 c.c. to neutralise 1.06 gr. Na_2CO_3, each 19.2 c.c. in stock

solution will require 0.8 c.c. water to make up to 20 c.c. The stock solution of acid is 2,000 c.c., as mentioned.

$$\text{Thus } \frac{2,000}{19.2} = 104.1.$$

$$\therefore 104.1 \times 0.8 = 83.2 \text{ c.c. water required.}$$

After additions have been made to the acid solution, repeated titrations with 1.06 gr. sodium carbonate must be carried out, showing well-agreeing results at 20 c.c. before the acid is passed as correct normal.

Standard Semi-Normal Sodium Hydroxide Solution.—To prepare Standard Semi-Normal Sodium Hydroxide (NaOH) Solution, take about 44 grammes pure sodium hydroxide (NaOH) sticks, and dissolve in about two litres of distilled water. Fill a graduated burette with the standard acid solution, also a burette with the sodium hydroxide solution. Run into a flask from the burette 25 c.c. of acid; two drops of phenol-phthalein are added, and then the solution of sodium hydroxide is run into the flask from the burette till the colour just turns yellow. As the alkali is half the strength of the standard acid, 25 c.c. acid should require 50 c.c. of the alkali solution to neutralise it. A strong solution of the sodium hydroxide is best diluted by the same method as used for the acid. Several titrations must be done with results agreeing at 25 c.c. acid requiring 50 c.c. alkali before the solution is passed as correct.

Testing for Carbonate of Lime.—In using the standard acid and alkali method for testing for $CaCO_3$ the raw material mixture (chalk or slurry) is dried and well ground in a mortar. Weigh out accurately 1 gramme, and transfer to a 200 c.c. flask. From the burette run in 25 c.c. of the standard acid, wash down the sides of the flask with some distilled water, then place on a hot plate and boil for a few minutes. Remove and add to the flask a few drops of phenol phthalein solution (indicator); now run in the standard alkali from a graduated burette until the solution turns a purple tinge (this point, when all the acid is neutralised, is very distinct), then take the reading on the burette.

The method of calculating the $CaCO_3$ is as follows: The number of c.c. alkali required, divided by two, gives the amount of acid neutralised by the alkali; which, subtracted from 25 c.c., gives the amount of acid used by the carbonate of lime in the slurry. This result, multiplied by five, gives the percentage of carbonate of lime. This calculation is arrived at from the chemical reactions in the following equation:

$$2HCl + CaCO_3 = CaCl_2 + H_2O + CO_2.$$

An explanation of this equation is as follows:

$$2\ HCl \quad + \quad CaCO_3$$
$$\underbrace{2\ (1+35\cdot5)} \quad + \quad \underbrace{40+12+48} = \&c.$$
$$\qquad 73 \qquad\qquad\qquad 100$$

The molecular weight of hydrochloric acid (HCl) is 36.5 and of carbonate of lime ($CaCO_3$) 100. Then 100 $CaCO_3$ requires 73.0 of HCl. Normal standard HCl contains 36.5 grammes hydrochloric acid in 1,000 c.c., therefore 1,000 c.c.

will decompose 50 grammes of carbonate of lime, therefore 20 c.c. hydrochloric acid will decompose 1 gramme of carbonate of lime.

Example.—1 gramme of cement raw material mixture treated with 25 c.c. of normal hydrochloric acid (HCl) and boiled on titration takes 19.6 c.c. of semi-normal sodium hydroxide (NaOH) to neutralise.   As 1 c.c. acid requires 2 c.c. alkali, then 19.6 c.c. divided by 2 equal 9.8 as the amount of acid neutralised by the alkali.   Then 9.8 c.c. subtracted from 25 c.c. (the amount of acid taken) leaves 15.2 c.c. which have been used up by the carbonate of lime.

Now, 20 c.c. acid = 1 gramme of carbonate of lime.

15.2 c.c. acid = 0.76   ,,   ,,

In 1 gramme of mixture there is   0.76   ,,   ,,

∴ In 100 grammes of mixture there is   76.0   ,,   ,,

= 76 per cent. $CaCO_3$.

Or the equation is as follows :

$$\text{Acid} - \frac{\text{c.c. of alkali}}{2 \times 5} = \text{per cent. of } CaCO_3.$$

In a well-appointed establishment, if the raw materials are found to vary in analysis, careful testing takes place as the materials are quarried, and the proportions are again corrected before the mixture is passed for the succeeding process of calcination—a stage, again, entirely dependent upon the accurate performance of these chemical tests and upon a due appreciation of the meaning and value of their results.

(To be continued.)

"False Set" of Cement.

A correspondent writes as follows from India :—

SIR,—The interesting articles which have appeared in " Cement and Cement Manufacture " on rapid-hardening Portland cement give only the standpoint as regards English climatic conditions. As engineers in India are now using rapid-hardening Portland cement for special work, perhaps these few remarks may be permitted.

It has not been clearly stated, I believe, whether this so-called " false set " is a regular happening or incidental. A certain well-known English brand of rapid-hardening cement was tried, and failed to pass the B.S.S. on setting time. On another occasion it passed. The authorities ruled that it must comply with the B.S.S., and used, we believe, 22 per cent. of water and under two minutes' gauging.

The writer has observed several samples of rapid-hardening cement which would comply with the B.S.S. with 22 per cent. to 26 per cent. of water and two minutes' gauging, but gauged with 25 per cent. of water and sometimes 24 per cent. and extended gauging up to four minutes it became normal setting. This testing question is becoming acute in a hot country like India. Is the B.S.S. to cover ordinary and rapid-hardening alike? Or should there be extenuating circumstances in favour of rapid-hardening cement?

The writer has come into close contact with grinding plants that gave considerable trouble with setting time on account of heavy charges of grinding bodies (and other details into which it is not necessary to enter here) raising the last temperature of the cement to over 170 deg. Centigrade. In both cases a suction fan and exterior-spray cooling caused the cement to become normal setting. The writer had the privilege some years ago of discussing the matter with the late Mr. S. G. Robinson, and we found on comparing notes that we had come across many things in common. In the two cases mentioned the quick setting was probably due to the partial de-hydration of the gypsum. Does this phenomenon occur with rapid-hardening cement, or is it due to something else? So far as the writer has observed with quick-setting cement it " dries " with increased percentages of water, whereas rapid-hardening cement does not appear to do so on extended gauging.

The writer (a minnow among tritons) would like to hear other people's experiences regarding dehydration of the gypsum, and high lime and fine grinding as quickening causes of false set. In conclusion, there is in India a recognised authority for testing, whilst in England we believe there is none, and the authorities here have, we know, read the articles in " Cement " on the subject with great interest, but the present indefinite state of r.h. leaves much to be desired.

C.E.H.